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# METHOD AND DEVICE FOR OPTICAL RECORDING AND METHOD AND DEVICE FOR OPTICAL REPRODUCTION

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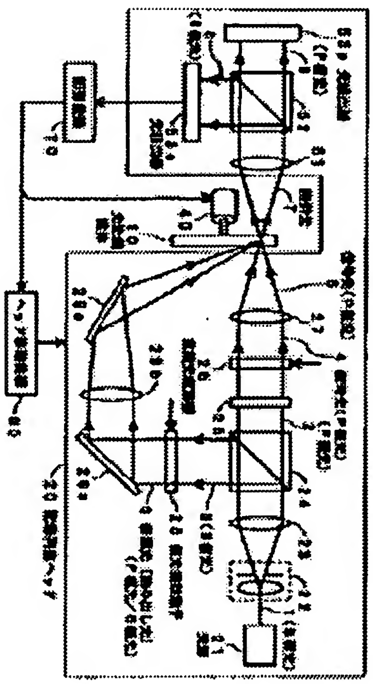
SPECIFICATION

(54) Title of the Invention

METHOD AND DEVICE FOR OPTICAL RECORDING AND METHOD AND DEVICE FOR OPTICAL REPRODUCTION



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[Claims]

[Claim 1] An optical recording method, in which a first signal light holding two-dimensional data information according to a spatial intensity distribution and containing an alignment pattern is recorded on an optical recording medium as a first hologram, next a diffraction light is reproduced from the recorded first hologram, said alignment pattern is detected, a second signal light holding a dimensional data information

according to a spatial intensity distribution and containing no alignment pattern is recorded as a second hologram in a region of said optical recording medium recorded with said first hologram by changing the polarization angle of a reference light or a signal light in the recording of said first hologram in a state that the relative position of said signal light and said optical recording medium is controlled by the detection signal.

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[1]Numbers in the margin indicate pagination in the foreign text.

[Claim 2] An optical recording device, which has
a light source emitting a coherent light,
a spatial light modulator modulating the intensity of a light from said light modulator in accordance with a dimensional data information and giving a signal light holding the dimensional data information according to a spatial intensity distribution,
an imaging optical system illuminating said signal light on an optical recording medium,
a reference light optical system giving a reference light from said light source and illuminating said reference light on said optical recording medium,
a polarization rotating element rotating the polarization angle of said reference light or signal light,
a light detector detecting the intensity of polarization components of a predetermined deflection angle in diffraction lights from the holograms recorded in said optical recording medium, and
a control means controlling the relative position of said optical recording medium and a recording head containing said light source, spatial light modulator, imaging optical system, reference light optical system, polarization rotating element and light detector.

[Claim 3] An optical recording device, which is characterized by the fact that said optical recording medium has

a disk shape, and said optical recording device has a medium driving mechanism rotating said optical recording medium and a head shift mechanism shifting said recording head in the radial direction of said optical recording medium
in the optical recording device of Claim 2.

[Claim 4] An optical reproduction method, in which a two-page signal light holding a dimensional data information in accordance with a spatial intensity distribution and added with an alignment pattern only on one page changes the polarization angle of a reference light or a signal light for each page, respectively, a reading light is illuminated on an optical recording medium recorded with the lights as holograms in same region, respectively, diffraction lights are simultaneously reproduced from said two-page holograms, said alignment pattern is detected from said two-page holograms, and a dimensional data information of the pages is separated and read from said diffraction lights in a state of controlling the relative position of said reading light and said optical recording medium by the detection signal.

[Claim 5] An optical reproduction device, which has
a reading light optical system wherein a two-page signal light holding a dimensional data information in accordance with a spatial intensity distribution and added with an alignment pattern only on one page changes the deflection angle of a

reference light or a signal light for each page, respectively, a reading light is illuminated on an optical recording medium recorded with the lights as holograms in same region, respectively, and said two-page holograms are read out simultaneously,

a diffraction light optical system separating the diffraction lights from the two-page holograms into two polarization components perpendicular to each other,

two light detectors detecting the intensities of the two polarization components, and

a control means controlling the relative position of said optical recording medium and a reproduction head containing said reading light optical system, diffraction light optical system and light detectors.

[Claim 6] An optical reproduction device, which is characterized by the fact that said optical recording medium has a disk shape, and said optical reproduction device has a medium driving mechanism rotating said optical recording medium and a head shift mechanism shifting said reproduction head in the radial direction of said optical recording medium

in the optical reproduction device of Claim 5.

[Claim 7] An optical recording medium, in which a two-page signal light holding a dimensional data information in accordance with a spatial intensity distribution and added with

an alignment pattern only on one page changes the deflection angle of a reference light or a signal light for each page, respectively and recorded with the lights as holograms in same region, respectively.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] This invention relates to a method and a device for recording two-dimensional data information on an optical recording medium as holograms and a method and a device for reproducing them from the optical recording medium.

[0002]

[Prior Art] Rewritable optical disks such as phase-change type and photomagnetic type disks, etc. have been popularized already. As compared with common magnetic disks, these optical disks have high recording density, but the beam spot diameter must be reduced and the distance of adjacent tracks or adjacent bits must be shortened to raise the recording density.

[0003] DVD is given as one practically used disk by development of such a technique. A DVD-ROM exclusive for reading can record 4.7 Gbyte on one side of a 12 cm-diameter disk. A writable/deletable DVD-RAM makes possible a high-density recording of 5.2 Gbyte on both sides of a 12 cm-diameter disk by phase-change mode.

[0004] Thus, the density raising of optical disks has been in progress year by year, on the other hand, the recording density of above optical disks is limited by the diffraction limit of light and approaches to 5 Gbit/in$^2$ which is said to be a physical limit of high-density recording because the above disks record data in a plane. Therefore, a three-dimensional (volumetric type) recording including the depth direction becomes necessary make an even larger capacity.

[0005] Accordingly, a hologram memory combining a large capacity property originated in a three-dimensional /3

recording - region and a high-speed property originated in a two-dimensional lump-sum recording/reproduction mode has attracted attention as a computer file memory of next generation.

[0006] In the hologram memory, multiple data pages multiplexed in same volume can be recorded and the data can be read out in a lump for each page. It is not an analog picture, becomes a digital picture with two-valued digital data 「0, 1」 as 「bright, dark」 and also makes possible the recording/reproduction of digital data by recording/reproducing the picture as hologram. More recently, a specific optical system of this digital hologram memory system, evaluation of SN ratio or bit error rate based on a volumetric multiplexed recording method has been proposed, and a study from an optical viewpoint, such

as effect of aberration of an optical system has also been advanced fur-ther.

[0007] A shift multiplex recording mode being one example of the volumetric multiplexed recording mode shown in a reference 「D. Psaltis, M. Levene, A. Pu, G. Barbastathis and K. Curtis, *Opt. Lett.* **20**, 782 (1995)」 is shown in Fig. 6.

[0008] In the shift multiplex recording mode shown in this reference, a hologram recording medium **91** is made into a disk shape, an object light **93** obtained via a spatial light modulator **92** is Fourier transformed by a lens **94**, a reference light **96** of spherical wave obtained via an object lens **95** is illuminated on the hologram recording medium **91** simultaneously with illuminating the light on the hologram recording medium **91**, and multiple holograms are overwritten in same region by rotation of the hologram recording medium **91**. For example, if the beam diameter is taken as 1.5 mmφ, another hologram can be recorded in nearly the same region without causing crosstalk by moving the hologram recording medium **91** for a few 10 :m. This mode utilizes the fact that it is equivalent to changing the angle of a reference light **96** by the shift of the hologram recording medium **91** because the reference light **96** is a spherical wave.

[0009] Thus, the hologram can be recorded/reproduced in the two-dimensional direction of medium surface and an increase of

memory capacity and an improvement of data transfer speed can be contrived by rotating an optical recording medium as a disk shape.

[0010] However, when the hologram is thus recorded/reproduced in the two-dimensional direction of medium surface, if the relative position of the optical system and optical recording medium for recording/reproduction does not accurately conform in both track direction horizontal to medium surface and focusing direction perpendicular to medium surface, the SN ratio of recording/reproduction reduces. Particularly, a recorded/reproduced signal is a two-dimensional data information as shown in Fig. 5(A), a high-accuracy alignment is needed because each pixel is of a size of at most about a few 10 :m.

[0011] Therefore, as shown in Fig. 5(B), a method has been considered wherein an alignment pattern Pa is added to portions of m×n pixels on each of four corners in a signal light of M×N pixels of each page, a hologram is recorded, and the relation position of optical system and optical recording medium is controlled by a detection signal of portions of this alignment pattern in a hologram diffraction light in the reading.

[0012]

[Problem to Be Solved by the Invention] In this method, however, 4×m×n pixels among M×N pixels available in each page cannot be used for recording/reproduction of data information

and cause a decrease of memory capacity and a reduction of data transfer speed. Moreover, even for a two-dimensional spatial light modulator for signal light formation in the reading and a two-dimensional light detector for diffraction light detection in the reproduction, M×N pixels of data information of (M×N - 4×m×n) pixels for recording/reproduction are needed, this results in a cost up of spatial light modulator and in its turn results in a cost up of recording/reproduction device.

[0013] Accordingly, this invention can make an alignment of optical system and optical recording medium even if an alignment pattern is not added to all pages of a signal light, thereby it can contrive an increase of recording capacity and an improvement of data transfer speed and contrive cost reduction of a recording/reproduction device.

[0014]

[Means for Solving the Problem] In the optical recording method of this invention, a first signal light holding dimensional data information according to a space intensity distribution and containing an alignment pattern is recorded on an optical recording medium as a first hologram, next a refraction light is reproduced from the recorded first hologram, said alignment pattern is detected, a second signal light holding a dimensional data information according to a space intensity distribution and containing no alignment pattern is

recorded in a region of said optical recording medium recorded with said first hologram as a second hologram by changing the polarization angle of a refer-ence light or a signal light in the recording of said first hologram in a state that the relative position of said signal light and said optical recording medium is controlled by the detection signal.

[0015] In the optical reproduction method of this invention, a two-page signal light holding a dimensional data information accordance to a spatial intensity distribution and added with an alignment pattern only on one page changes the deflection angle of reference light or signal light for each page, respectively, a reading light is illuminated on an optical recording medium recorded as hologram in the same region, respectively, a diffraction light is simultaneously reproduced from said two-page hologram, said alignment pattern is detected from said two-page hologram, and a dimensional data information of each page is separated and read from said diffraction light in a state of controlling the relative position of said reading light and said optical recording medium by the detection signal.

[0016]

[Functions] A material showing the photo-induced birefringence (photo-induced anisotropy, photo-induced dichroism) can induce a polarized state of a light entering into

it and record the deflection angle (direction of polarization) of the incident light. For example, if a linear polarization /4 is illuminated on a polymer in which a polymer or a polymer liquid crystal with a photoisomering group in side chain, or a polymer dispersed with photoisomering molecules, a photoisomerization is caused in accordance with the direction of said linear polarization, the anisotropy of refractive index is generated in accordance with the direction of linear polarization, the direction of polarization can be recorded and stored. At this time, if a reference light is illuminated simultaneously, the deflection angle of signal light can be recorded as hologram.

[0017] A common hologram is recorded by making the directions of polarization of a signal light (object light) and a reference light identical (parallel). The hologram thus recorded or a recorded hologram is called an intensity modulated hologram in this specification.

[0018] By contrast, a material showing the above photo-induced birefringence can make the directions of polarization of a signal light and a reference light perpendicular and record the signal light as hologram. The hologram thus recorded or a recorded hologram is called a polarization modulated hologram in this specification. However, the polarization modulated hologram can also be spatially intensity modulated in accordance with a

two-dimensional data information like the intensity modulated hologram.

[0019] For example, a signal light of P polarization can be recorded as an intensity modulated hologram with a reference light of P polarization and can be recorded as a polarization modulated hologram with a reference light of S polarization. The signal light of P polarization recorded as an intensity modulated hologram can be reproduced as a diffraction light of S polarization with a reading light of S polarization, and the signal light of P polarization recorded as a polarization modulated hologram can be reproduced as a diffraction light of P polarization with a reading light of S polarization. The polarization angle of a signal light may be changed in place of changing the polarization angle of a reference light in the reading.

[0020] In the optical recording method of this invention, first, a first signal light holding a two-dimensional data information according to a spatial intensity distribution and containing an alignment pattern is recorded on an optical recording medium as first hologram, e. g., an intensity modulated hologram by means of the method.

[0021] Next, a diffraction light is reproduced from the recorded first hologram, e. g., an intensity modulated hologram, the alignment pattern is detected, and the relative position of

the signal light and optical recording medium is controlled with the detection signal. For example, if the signal light of P polarization is recorded with a reference light of P polarization and the intensity modulated hologram as the first hologram, a hologram diffraction of S polarization is obtained with a reading light of P polarization, thus the alignment pattern can be detected.

[0022] Next, a second signal light holding a two-dimensional data information according to a spatial intensity distribution and containing no alignment pattern is recorded e. g., as a polarization modulated hologram on a region of the optical recording medium recorded with the first hologram, e. g., the intensity modulated hologram as a second hologram by changing the polarization angle of said reference light or signal light in the recording of the first hologram in a state of making an alignment of said signal light and optical recording medium.

[0023] Therefore, a two-page signal light can be recorded in same region of the optical recording medium as holograms, respectively only by adding an alignment pattern only to the page of signal light recording first.

[0024] After the multiplex recording was made in this manner, the intensity modulated hologram and the polarization modulated hologram of the optical recording medium can be

simultaneously reproduced as diffraction lights whose directions of polarization are perpendicular to each other by illuminating a reading light to the region where the intensity modulated hologram and the polarization modulated holograms are multiplex recorded. For example, when the signal light of P polarization is recorded with a reference light of P polarization, the intensity modulated hologram gives a diffraction light of S polarization from intensity modulated hologram; when the signal light of P polarization is recorded with a reference light of S polarization, the polarization modulated hologram gives a diffraction light of P polarization from the polarization modulated hologram by illuminating a reading light of S polarization, respectively.

[0025] Therefore, the hologram diffraction lights are separated into an S polarization component and a P polarization component by a polarization beam splitter, etc., the data information recorded as intensity modulated hologram and the data information recorded as polarization modulated hologram can be separated in a high SN ratio and simultaneously read by detecting the respective polarization components with separate light detectors.

[0026] Moreover, the alignment of said reading light and optical recording medium can be simultaneously made for the two-page holograms of intensity modulated hologram and polarization

modulated hologram according to an alignment pattern added only to one hologram, e. g., the intensity modulated hologram.

[0027] As described above, this invention enables to make an alignment of optical system and optical recording medium without an alignment pattern on all pages of a signal light, thereby it enables to contrive an increase of recording capacity and an improvement of data transfer speed and contrive cost reduction of a recording/reproduction.

[0028] For example, when an alignment pattern is added to a portion of m×n pixels among M×N pixels of initial page to each of four corners, data information of pixels 4×m×n more than that in the conventional method can be recorded in a region of optical recording medium with same surface area by two pages. Conversely, when data information of same amount as that in conventional method is recorded, the surface area of recording region of that portion can be reduced, and the number of pixels of spatial light modulator for signal light formation and light detector for diffraction light detection can be decreased.

[0029]

[Embodiment Form of the Invention] (Example of Optical Recording Medium) Fig. 1 shows one example of optical recording medium used in the method of this invention, and a polarized induction layer **12** is formed on one side of a /5

transparent substrate **11** such as glass substrate, etc.

[0030] The polarized induction layer **12** may be any material if it is a material which exhibits the photo-induced birefringence and can record polarized information as hologram, but a polymer or a polymeric liquid crystal with a photoisomerizing group in side chain can be used as preferable example. Moreover, for example, photoisomerizing groups or molecules containing an azobenzene skeleton are preferable.

[0031] As one preferable example of the polarized induction layer **12**, a polyester having cyanoazobenzene in side chain expressed by a chemical formula shown in Fig. 2 can be used. As described in detail in Japan Appl. 10-32834, the recording, reproduction and deletion of holograms having polarization information are made possible by the photo-induced anisotropy caused by the photoisomerization of cyanoazobenzene in side chain.

[0032] The thickness of polarized induction layer **12** must be at least 10 :m to record holograms volumetrically (three-dimensionally), the larger the thickness, the more the memory capacity can be increased. The entire optical recording medium **10** can also be formed as a polarized induction layer exhibiting the photo-induced birefringence.

[0033] (Example of Optical Recording Device and Optical Reproduction Device) Fig. 3 shows one example of the optical

recording device and optical reproduction device of this invention.

[0034] A light source emitting a coherent light sensitive to the polarized induction layer of optical recording medium **10** is used as light source **21** of a recording/reproduction head **20**. For example, when the polyester with cyanoazobenzene in side chain shown in Fig. 2 is used as polarized induction layer, an argon laser of 515 nm in wavelength sensitive to the layer is used.

[0035] The polarization of a light **1** from the light source **21** is made to a parallel light by a lens **23** and further divided into two beams by a beam splitter **24** after this light **1** of S polarization passes through a spatial filter **22** to remove disturbance of wave surface, e. g., by an S polarization perpendicular to the paper surface.

[0036] Then, a shutter **25** is opened and a light **2** of P polarization transmitting the beam splitter **24** is entered into a spatial light modulator **26** for signal light formation in the recording. A two-valued two-dimensional data picture which contains an alignment pattern as shown in Fig. 5(B) or contains no alignment pattern as shown in Fig. 5(A) is displayed by a control circuit omitted in the diagram. Thereby, a light **4** transmitting the spatial light detector **26** is spatially intensity modulated in accordance with the value of each pixel

of the two-dimensional data picture and becomes a signal light of P polarization holding two-dimensional data information according to the spatial intensity distribution. A liquid crystal panel, etc. can be used as such a spatial light detector **26**.

[0037] The signal light **4** of P polarization from this spatial light detector **26** is Fourier transformed by a lens **27**, and the signal light **5** of P polarization after the transformation is illuminated on an optical recording medium **10**.

[0038] Simultaneously, a light **3** of S polarization reflected by the beam splitter **24** is entered into a polarization rotating element **28**, and the polarization angle of the light transmitting through the polarization rotating element **28** is rotated in accordance with a control signal from the control circuit omitted in the diagram. A liquid crystal valve, Pockels element, Faraday element, 1/2 wavelength plate, etc. can be used as polarization rotating element **28** which can rotate the polarization angle of transmitting light in such a manner.

[0039] A reference light of P polarization or S polarization is obtained as a light **6** transmitting this polarization rotating element **28** in the recording. Then, a reference light **6** of P polarization or S polarization is reflected by a mirror **29a**, converged by a lens **29b**, reflected by a mirror **29c** and illuminated on a region illuminated by the

signal light **5** of the optical recording medium **10** in the recording.

[0040] Thereby, the spatial intensity distribution of the signal light **5** of P polarization in the optical recording medium **10** is recorded as an intensity modulated hologram when the reference light **6** is P polarization and a polarization modulated hologram is recorded when the reference light **6** is S polarization, respectively.

[0041] In the reproduction (reading), the shutter **25** is closed to shield the signal light **5**, a reading light of S polarization is obtained as a light **6** transmitting the polarization rotating element **28** and illuminated on a region recorded with the holograms of the optical recording medium **10**. The illuminated reading light **6** is diffracted by the holograms, and a diffraction light **7** is obtained on the optical path of signal light **5**.

[0042] When the reading light **6** of S polarization is illuminated in a state that the signal light **5** of P polarization is first recorded only as the intensity modulated hologram by the reading light **6** of P polarization in case of a hologram multiplex recording described later, a diffraction light of S polarization from the intensity modulated hologram is obtained as a diffraction light **7**. After the intensity modulated hologram and the polarization modulated hologram are multiplex recorded

in same region of the optical recording medium **10**, when the reading light **6** of S polarization is illuminated, a component of S polarization from the intensity modulated hologram and a component of P polarization from the polarization modulated hologram are obtained as the diffraction light **7**.

[0043] The diffraction light **7** is made to a parallel light by a lens **51**, entered into a polarization beam splitter **52**, separated into an S polarization component **8** reflected by the polarization beam splitter **52** and a P polarization component **9** transmitting the polarization beam splitter **52**, the S polarization component **8** is imaged on a light detector **53s** to read its spatial intensity distribution, and the P polarization component **9** is imaged on a light detector **53p** to read its spatial intensity distribution. Therefore, data information recorded as the intensity modulated hologram and data information recorded as the polarization modulated hologram can be separated in a high SN ratio and read simultaneously.

[0044] (Example of Hologram Multiplex Recording) When the intensity modulated hologram and the polarization modulated /6 hologram are multiplex recorded in same region of the optical recording medium **10** in the above-mentioned device, as shown in a multiplex recording processing routine 100 of Fig. 4, first, in a step 101, a light containing an alignment pattern as shown in Fig. 5(B) is obtained as the signal light **5** of P polarization

(4), a reference light of P polarization is obtained as the light 6 transmitting the polarization rotating element 28, the both are simultaneously illuminated on the optical recording medium 10, and the intensity modulated hologram is recorded in the optical recording medium 10.

[0045] Next, in a step 102, the signal light 5 is shielded, the read light of S polarization is obtained as the light 6 transmitting the polarization rotating element 28 and is illuminated on the optical recording medium 10, the intensity modulated hologram recorded in the optical recording medium 10 in the step 101 is reproduced as the diffraction light 8 of S pola-rization and its intensity is detected by the light detector 53s, a head shift mechanism 60 and a motor 40 are controlled by a control circuit 70 based on a detection signal of the align-ment pattern contained in the intensity modulated hologram to make an alignment of a recording/reproduction head 20 and the optical recording medium 10.

[0046] Then, if the alignment of the recording/reproduction head 20 and the optical recording medium 10 is made in such a manner, in a step 103, a hologram containing no alignment pattern as shown in Fig. 5(A) is obtained as the signal light 5 of P polarization (4), the light 6 transmitting the polarization rotating element 28 is taken as reference light as it is S polarization, the both are simultaneously illuminated on the

region of the optical recording medium **10** recorded with the intensity modulated hologram and multiplexed into the intensity modulated hologram to record the polarization modulated hologram in this region.

[0047] In the step 103, the signal light **5** transmits the optical recording medium **10** and enters into the polarization beam splitter **52** via the lens **51**, but the signal light **5** does not exert an influence on positional control with the control circuit **70** based on the detection of S polarization component **8** with the light detector **53s** because the signal light **5** is S polarization.

[0048] (Example of Hologram Multiplex Reproduction) When the intensity modulated hologram and the polarization modulated hologram multiplexed by the above method are simultaneously reproduced, the signal light **5** is shielded, a read light of S polarization is obtained as the light **6** transmitting the polarization rotating element **28** and illuminated on the region of the optical recording medium **10** multiplex recorded with the intensity modulated hologram and the polarization modulated hologram.

[0049] Thereby, a diffraction light **8** of S polarization is obtained as diffraction light from the intensity modulated hologram containing the alignment pattern, and a diffraction light **9** of P polarization is obtained as diffraction light from

the polarization modulated hologram containing no alignment pattern. Therefore, a head shift mechanism **60** and a motor **40** are controlled by a control circuit **70** based on a detection signal of the alignment pattern with a light detector **53s** to make an alignment of the recording/reproduction head **20** and the optical recording medium **10**.

[0050] Then, the data information recorded as the intensity modulated hologram is read from a portion other than the alignment pattern of the diffraction light **8** of S polarization from the intensity modulated hologram in the light detector **53s** in such an aligned state, the data information recorded as the polarization modulated hologram is read from the diffraction light **9** of P polarization from the polarization modulated hologram in a light detector **53p** in such an aligned state, the data information recorded as the intensity modulated hologram and the data information recorded as the polarization modulated hologram can be separated in a high SN ratio and reproduced simultaneously.

[0051] (Verification by Experiment) The recording/reproduction of two-dimensional data information were actually tried by the above-mentioned method and device. A recording medium given by forming a polyester with cyanoazobenzene in side chain as a polarized induction layer was used as the optical recording medium **10**, and an argon ion laser

was used as the light source **21**. A signal light and a reference light in recording were taken as about 0.5 W/cm$^2$, and a reading light in reproduction was taken as 0.15 W/cm$^2$. A liquid crystal panel of 640×480 pixels (size of pixel 42 :m × 42 :m) for projector was used as the spatial light modulator **26**.

[0052] Consequently, the intensity modulated hologram and the polarization modulated hologram could be recorded in same region of the optical recording medium, and each could be well reproduced as two-dimensional two-valued picture of the S polarization component **8** and P polarization component **9** without crosstalk. Moreover, a high-accuracy alignment of pixel units could be realized only by the alignment pattern added to the intensity modulated hologram.

[0053] (Device Exclusive for Recording or Exclusive for Reproduction) The example of Fig. 3 is a case of performing the recording and reproduction in same device, but it can also be taken as a device exclusive for recording (however, including a hologram reproduction for alignment) or reproduction. In the device exclusive for recording, the polarization beam splitter **52** and the light detector **53p** in the above examples are unnecessary, the small size and lightening of the recording head and the cost reduction of recording device can be realized by excluding them. In the device exclusive for reproduction, the shutter **25**, the spatial light modulator **26** and the lens **27** as

well as the beam splitter **24** and the polarization rotating element **28** depending upon constitution are unnecessary, the small size and lightening of the reproduction head and the cost reduction of reproduction device can be realized by excluding them.

[0054]

[Effects of the Invention] As described above, this invention enables to make an alignment of optical system and optical recording medium without adding an alignment pattern to all pages of a signal light, thereby it enables to contrive an increase of recording capacity and an improvement of data transfer speed and enables to contrive cost reduction of a recording/ reproduction device.

[Brief Description of the Drawings]

[Fig. 1] Diagram showing one example of an optical recording medium used in the method of this invention.

[Fig. 2] Diagram showing a chemical formula of one example of material in polarized induction layer of optical /7
recording medium.

[Fig. 3] Diagram showing one example of optical recording device and optical reproduction device of this invention.

[Fig. 4] Chart showing one example of a multiplex recording processing routine.

[Fig. 5] Chart showing examples of a signal light containing no alignment pattern and a signal light containing alignment pattern.

[Fig. 6] Diagram for illustrating a shift multiplex recording mode.

[Description of the Symbol]

4, 5 ・ signal lights

6 ・ reference light, reading light

7 ・ diffraction light

10 ・ optical recording medium

12 ・ polarized induction layer

20 ・ recording/reproduction head

21 ・ light source

24 ・ beam splitter

25 ・ shutter

26 ・ spatial light modulator

28 ・ polarization rotating element

40 ・ motor

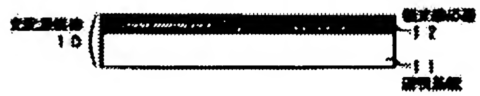
52 ・ polarizing beam splitter

53s, 53p ・ light detectors

60 ・ head shift mechanism

70 J control circuit

[Fig. 1]

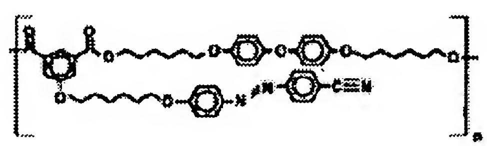


10 J optical recording medium

11 J transparent substrate

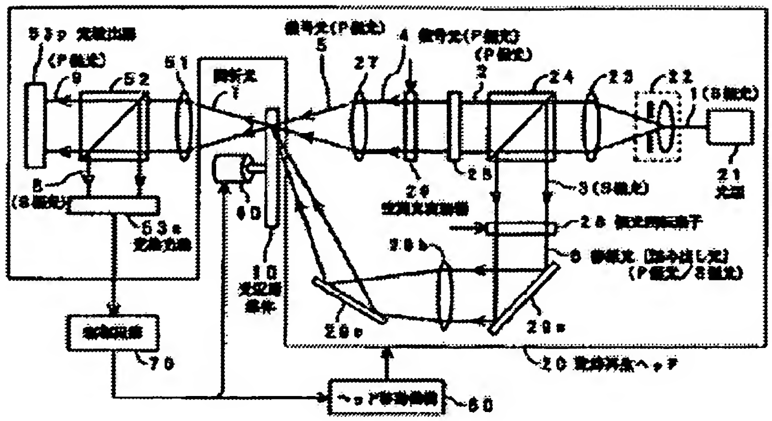
12 J polarized induction layer

[Fig. 2]



<u>Polyester with cyanoazobenzene in side chain</u>

[Fig. 3]



2 J P polarization

3 J S polarization

4, 5 J signal lights (P polarization)

6 J reference light [reading light] (P polarization/S polarization)

7 J diffraction light

8 J S polarization

9 J P polarization

20 J recording/reproduction head

21 J light source

26 J spatial light modulator

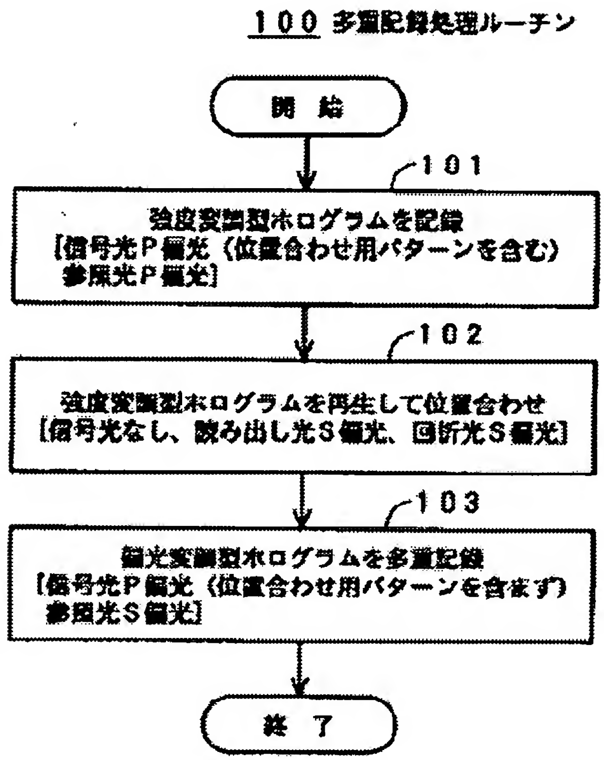
28 J polarization rotating element

53s, 53p J light detectors

60 J head shift mechanism

70 J control circuit

[Fig. 4]




100 Multiplex Recording Processing Routine

START

↓

101 Record intensity modulated hologram

[signal light P polarization (containing alignment pattern)

reference light P polarization]

↓

102 Reproduce and align intensity modulated hologram

[no signal light, reading light S polarization, diffraction light P polarization

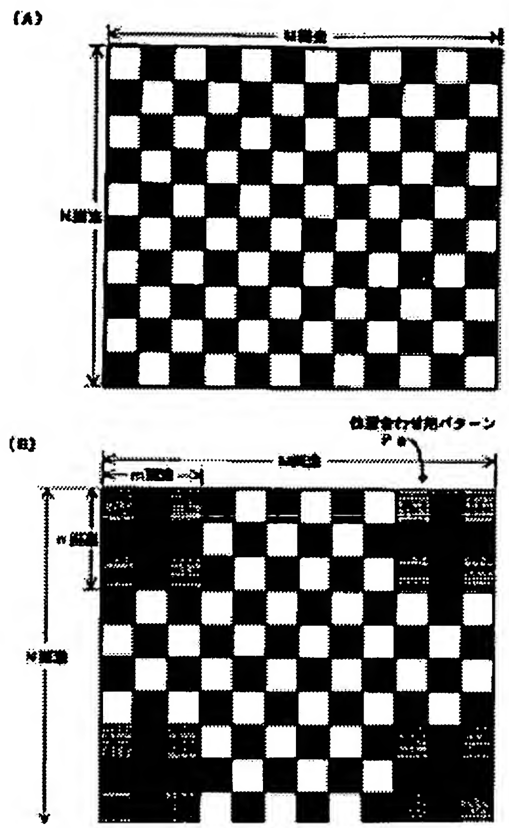
↓

103 Multiplex record polarization modulated hologram [signal light P polarization (no alignment pattern) reference light S polarization]

↓

END

[Fig. 5]



(A)

M pixels

N pixels

(B)

M pixels

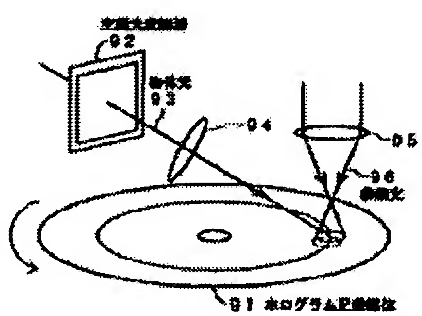
m pixels

Pa alignment pattern

n pixels

N pixels

[Fig. 6]




**91** hologram recording medium

**92** spatial light modulator

**93** object light

**96** reference light